An Unmanned Helicopter System

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Abstract

This paper introduces the test bed of the unmanned aerial vehicle for automatic flight controls. The small unmanned system consists of a radio-control helicopter as a basic aircraft, including an Arduino-compatible controller and a pressure sensor. It measures 0.64 m long with 0.35 m wide of main rotor diameter and weighs approximately 2 kilograms. The unmanned helicopter aims for implementing automatic flight controls. Experimental results are presented for both the test bed mounted on a flying stand and a real flight condition.

***Keywords**:* UAV, Helicopter, Test bed

1. Introduction

Unmanned aerial vehicles (UAV) are interested in the academic research in the past years. It serves as a platform for many research applications. The unmanned aerial vehicles also have great potentials in military and civil applications [1]. This is because of their maneuverability and versatility [2]. An UAV helicopters are chosen for various research groups as they are small and versatile. The motivation is to develop an UAV helicopter as a test bed to verify the flight control system. A typical UAV system consists of a helicopter aircraft with electric motors, avionic system for flight control and a ground supporting system.

The outline of this paper is as follows: Section 2 presents details of an UAV helicopter. Section 3 describes a simple autopilot system. Section 4 presents a control system for an UAV platform. Implementation results are shown in Section 4. Finally, section 5 draws some concluding remarks.

2. UAV Helicopter

A radio-controlled (RC) helicopter shown as the Fig. 1, is chosen as the aircraft. The selected model is suitable as it can be easily upgraded to be an UAV helicopter with a complete autopilot and sensing system. This would be appropriate for implementation of flight control. Furthermore, the RC helicopter is cheaper than a full set of commercial UAV system.

The Trex 450Pro RC helicopter is high quality available in the hobby market. It is capable of performing stable hover and agile flight. It is ideal for performing as the basic UAV helicopter. The dimension of the miniature Trex 450 helicopter is shown in Table 1.

Fig. 1 Basic helicopter

Table. 1 Dimension of the Trex 450Pro RC helicopter

Full length of fuselage	635 mm
Total height	310 mm
Main rotor diameter	710 mm
Tail rotor diameter	316 mm

The main gear ratio in the helicopter is 11.54:1 and the main gear to tail ratio is 11.54:4.24. The maximum taking-off weight of the helicopter is up to 2 kg, whilst the helicopter itself weights about 600 g. This provides a load up to 1.5 kg which is for other components to be attached to the main body. Fig. 2 shows the size of helicopter used as a basic platform. However, it is still effective for mixing control modes, namely automatic flight control and manually operating mode.

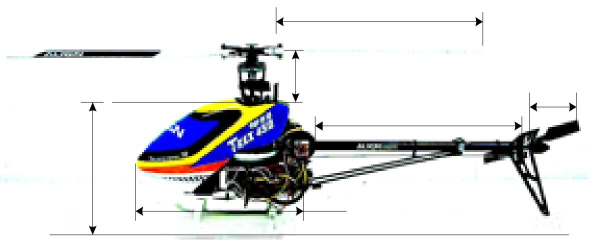

Fig. 2 Dimension of the UAV helicopter

3. Simple Autopilot System

A simple autopilot system is designed to upgrade the chosen RC helicopter discussed in the previous section. The system aims both automatic flight control and manual operation control. The computing system installed on the helicopter is an Arduino-compatible controller. It is off-the-shelf autopilot system based on 8-bits microcontroller. It is reliable and cheap available in the market. The autopilot is an Arduino open-source hardware and software platform which is appropriate for any modifications. Sensing is undertaken through the use of a pressure sensor and a preinstalled rate gyroscope. Although the gyroscope can not measure the relative motion between the aircraft and the surrounding, they can provide sufficient signal to maintain the stability of the helicopter. Installation of components on the helicopter is shown in Fig. 3.

Fig. 3 Installation of electronic components (left-right view).

4. Control System

Autopilot schematic diagram for control system is shown in Fig. 4. The original manual control system of the helicopter is kept in the autopilot system. The manual control is useful for an auxiliary mode of the UAV helicopter. The can be switched between modes. The manual mode is necessary because it can avoid disorder of the flight of the UAV helicopter. In the manual mode, the airbourne platform is radio-controlled by six-channels radio transmitter. For these preliminary experiments, only on-off signal for starting and shutting down the UAV helicopter are sent between receiver and transmitter. In the automatic mode, an autopilot system executes the flight control mission. Based on the height data from the pressure sensor, the airbourne computing system plays important role in commanding the servos for the flight in real time. The driven system uses a brushless DC motor to spin the main rotor and tail rotor in a fixed gear ration as mention earlier. To control the motors, an Electronic Speed Controller (ESC) is installed. To interact the controller with the Arduino controller it is necessary to have a system that could produce the standard pulse width modulated (PWM) signal used by the RC system to set the motors demand. Another three servos linked to the swashplate control collective and cycle angles of the attack of the main rotor blades. A 11.1V/2200mAh Li-po battery pack is used to supply power to the servos and the ESC. Another 7.4V/1000mAh batter pack is used to supply power to the autopilot system.

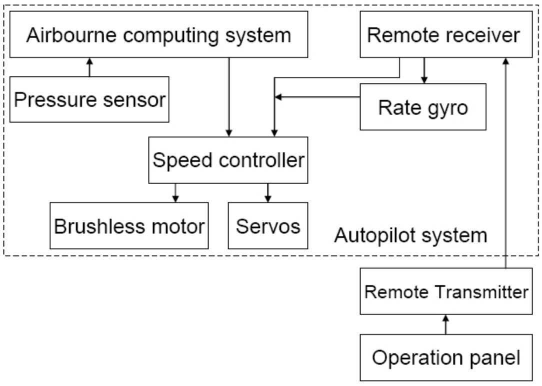

Fig. 4 Autopilot schematic diagram

5. Tests

Two implementations are demonstrated in this paper. At first the developed system involves the UAV helicopter mounted on a flying stand. The mechanical construction is shown in Fig. 5. The mechanism is for safety during experimentations. The indoor flying gives the ability for tests regardless of weather conditions. A sequence of snap shots shown in Fig. 6 demonstrates flight test on the flying stand.

Fig. 5 Design of a flying stand

Secondly, the real flight is to perform. Insufficient control may result to unexpected behavior so a mechanical landing gear (see Fig. 7) is design and attached to the UAV helicopter. This allows reduction of crashes and damages that may appear during experimentations. The real flight is demonstrated in Fig. 7.

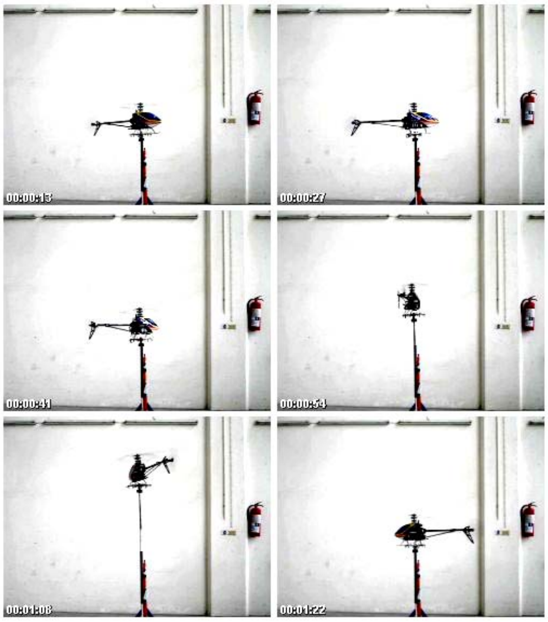

Fig. 6 Snap shots of test on a flying stand

Fig. 7 Landing gear mechanism

6. Conclusion

In this paper, a design and fabrication of an UAV helicopter is presented. Upgrade RC helicopter platform is chosen integrated with a simple avionic system. The 8-bits Arduino autopilot system is selected as the airborne system. Attitude date is collected via a pressure sensor equipped on the UAV helicopter. Two modes of automatic and manual operation can be switched to control the UAV helicopter. Demonstration results show that the UAV has abilities to implement the automatic flight in actual conditions. The developed UAV helicopter has been tested fairly successfully in the automatic mode. In the future, an integration of wireless modem with ground control and advanced IMU sensory unit will improve the flight control and provide a safer system to real in-flight implementations.

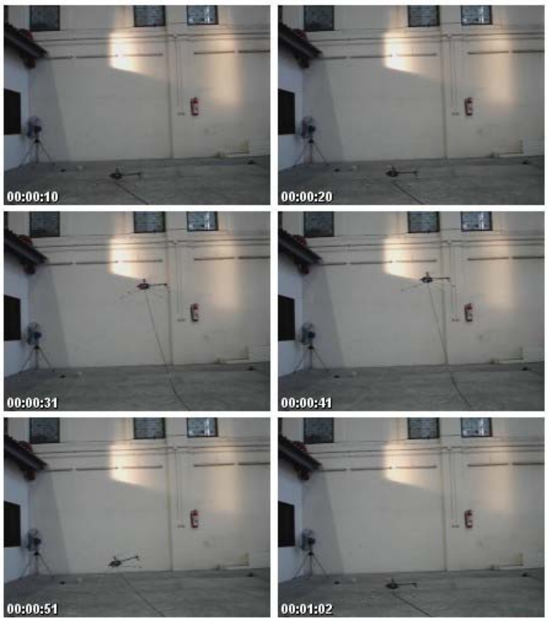

Fig. 7 Snap shots of actual flying test

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8. References

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